THIRD ANNUAL MONITORING REPORT FOR OPERABLE UNIT 1 MITIGATION WETLAND AT ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

Background

This is the third annual monitoring report for the mitigation wetland established in 1993 in Operable Unit (OU) 1 at the Rocky Flats Environmental Technology Site (RFETS), Colorado. This wetland was established as mitigation for a wetland area that was impacted by the OU1 French Drain Project. Monitoring of this mitigation wetland was requested by the Environmental Protection Agency (EPA) at a meeting held at RFETS on April 1, 1993. At this meeting, it was agreed that 2,000 square feet of wetland should be established with cattails planted on approximately one-foot centers, and that the minimum acceptable survival rate would be 85% (0.85 cattails per square foot). It was also agreed that a monitoring report would be submitted to EPA and the Colorado Department of Health (CDH)(now called the Colorado Department of Public Health and Environment) each year by the end of August, for a period of five years. The first annual monitoring report was transmitted to EPA and CDH in August 1993.

The OU1 mitigation wetland area at RFETS was planted with approximately 2200 broad-leaf cattail *(Typha latifolia)*, 100 soft-stem bulrush *(Scirpus validus)*, 100 Olney's bulrush *(Scirpus americanus)*, and 100 sandbar willow *(Salix exigua)* plants. The planting was done on May 6, 7, 10, and 11, 1993. The planting stock was obtained through a local nursery. The nursery obtained cattails from a grower in Montana because locally grown stock was not available within the time that EPA wanted the planting to be completed.

The cattail and willow planting materials consisted of 10 cubic inch containerized stock (containerized tubelings approximately 8" long). The cattail planting stock consisted of plants that had grown for one season in plastic conical containers. The stems had been cut back to approximately 1 inch, and the plants were just breaking dormancy. The soft-stem bulrush and Olney's bulrush planting material consisted of 2 inch square pots. The cattails were planted in holes made with sharpened broom handles. A tile spade was used to dig holes in which to plant the soft-stem bulrush, Olney's bulrush, and sandbar willow. The cattail was the only vegetation that EPA required in the mitigation wetland area. The sandbar willow, soft-stem bulrush, and Olney's bulrush were planted to add some diversity to the vegetation in the wetland.

At the time of planting, the water depth in the lowest (deepest) areas of the mitigation wetland was approximately one foot. Cattails were planted throughout the entire wetland mitigation area, even though some of the areas were submerged and some were likely too high and too dry for the cattails to survive during drier years. The soft-stem bulrush and Olney's bulrush were planted in isolated pockets among the cattails near the outside edges of the mitigation wetland. The willows were planted just outside the area planted with cattails, mostly along the north and south sides of the wetland. The area planted with willows was not included in the area identified as having been planted with cattails. The planted material was in good condition at the time of planting. Approximately 1-2% of the cattail tubelings did not have adequate root systems

developed to hold the planting medium together and appeared to be dead. These were not planted.

The mitigation wetland was first evaluated on August 17, 1993 to determine the density of cattails and the surface area covered by the cattails. At that time the cattail density was 3.1/ft^2, and the area covered by the planted cattails was approximately 1860 ft^2. This information was reported in the first annual mitigation report.

Monitoring Materials and Methods

A quadrat sampling method was used to determine the density of the cattails in the mitigation wetland. One half square meter quadrats (one meter x one half meter rectangles) were used to sample the vegetation on August 15, 1995. This quadrat size was considered to be large enough to reduce boundary error to acceptable levels, yet small enough that the number of plants within each quadrat could be accurately counted. Density was determined by counting the number of cattails showing current year growth in each quadrat. The quadrat counts were multiplied by 2 to obtain the density per square meter. The density per square meter was converted into a density per square foot (by dividing by 10.37) to allow comparison with the EPA criteria of an average density of one cattail per square foot.

The quadrat sampling procedure used to determine the density of cattails in the mitigation wetland is taken from the Comprehensive Onsite Determination Method, as described in both the 1987 Corps of Engineers Wetland Delineation Manual and the 1989 Federal Manual for Identifying and Delineating Jurisdictional Wetlands. This procedure is simply one way of randomly locating quadrats for sampling to give an estimate of the overall density within the population of interest. One minor modification to the procedure was necessary. The modification consisted of using five transects instead of the three that were recommended in the manuals. This was necessary in order to get enough sample plots to have a statistically valid sample size, without having to overlap quadrats along each transect.

The sampling procedure involved laying out a baseline perpendicular to the hydrologic gradient of the wetland. Sampling transects were then laid out perpendicular to the baseline. The transect locations were determined by dividing the baseline into a number of equal segments, and using a random number generator to determine the transect location within each segment.

Observation points were located along the transects at a random number-generated distance from the edge of the wetland. Quadrats were located on observation points along the transects by placing one corner of the transect on the observation point and placing one edge of the quadrat adjacent to the transect line. One half square meter rectangular quadrats were used. Quadrat frames were constructed of half inch PVC pipe.

Initially, six quadrats were counted. One quadrat was located in each of the four shortest transects, and two quadrats were located in the longest transect in order to assure that the entire wetland area was sampled. The values obtained from these quadrats were substituted into the following sample size estimation formula for a univariate normally distributed vegetation characteristic. This calculation gave the estimated number of samples that were necessary to obtain a 90 per cent confidence level (10% chance of error) that the sample mean obtained

from the quadrat counts was within 10% of the actual population mean. By using the following sample size estimation formula, it was calculated that 12 additional samples (quadrats) were needed, for a total of 18 quadrats. Numbers and calculations for the sample size estimation formula are shown on the field data form included at the end of this report.

$$n = \frac{t^2 s^2}{(kX)^2}$$

n = the number of samples required to obtain the required confidence level and precision.
t = the t-variable for the sample at the stated level of error.
s = the standard deviation of the sample.
k = the proportion or precision that the true difference of the sample mean occurs from the population mean.
X = the sample mean.

The area (size) of the mitigation wetland was determined by surveying in wire flags placed around the perimeter to identify the boundary of the surviving planted cattails. Flags were also used to mark the upslope boundary of the willows that were planted around the perimeter of the mitigation wetland. The area between the surviving cattails and the willows has become mostly covered by either facultative, facultative wet, or obligate wetland species. The area covered by the surviving cattails was measured by surveying. The area covered by the willows and other wetland vegetation was measured separately from the area covered by the cattails.

Results

A photograph of the mitigation wetland, taken August 10, 1995 is shown in Figure 1. The mean density of cattails in the mitigation wetland calculated from the 18 sample quadrats counted on August 15, 1995 was 1.3 cattails/ft^2 (14.10/m^2). The sample standard deviation for the one half square meter quadrat counts was 1.92.

The size of the area where planted cattails were surviving on August 15, 1995 was determined to be approximately 1574 ft^2. The area was determined by surveyors who measured the area inside surveying flags that had been placed around the perimeter of the cattails. This area does not include areas covered by the planted willows or the areas where planted cattails did not survive. The area of the mitigation wetland covered by the planted willows and by other naturally established species of facultative, facultative wet, and obligate wetland vegetation is approximately 394 ft^2. The entire area covered by either planted cattails or other wetland vegetation (facultative, facultative wet, and obligate) is 1968 ft^2. This is the surface area that would be considered to be wetland according to the current federal wetland delineation method.

Figure 1. Photo of Mitigation Wetland Looking Toward the Northwest.

Discussion

The average density of the cattails in 1995 (1.3/ft^2) is less than the density in 1994 (2.0/ft^2) and in 1993 (3.1/ft^2). This average density is still above the minimum density of 0.85 cattails/ft^2 required by the EPA.

The area of the surviving cattails (1574 ft^2) is somewhat smaller than it was last year (1670 ft^2). The difference in area is due primarily to the loss of cattails in the drier areas of the wetland since last year. Drier areas where cattails have not survived are now populated by willows and other species of facultative, facultative wet, and obligate vegetation.

Based on general observation, the planted cattails have become less evenly distributed each year since they were planted in 1993. The cattail density is low in areas that remained submerged for a period of weeks after planting. Survival was expected to be lower in these areas, since the young cattail plants are not able to withstand extended inundation unless the stems are long enough to protrude above the water. Cattails that were planted in the higher elevations have not survived. Apparently, these higher areas were too dry during the past two years for the cattails that were planted there to survive. These drier areas are still populated by the willows that were planted there, and by other wetland plants that are invading these drier areas.

Natural establishment of cattails is occurring mostly in the extreme west end of the wetland (Figure 2) and at the point where the drainage ditch coming down the hillside enters the wetland. Cattails in these two areas are much denser and taller than in other areas that were planted. Single quadrat counts in these two areas showed densities of 8.5 cattails/ft^2 (88/m^2) in the west end, and 5.0 cattails/ft^2 (52/m^2)where drainage ditch enters the wetland. These denser cattails are probably a result of a combination of growth from seeds and from rhizomes extending from adjacent, well-established cattail plants. These plants were not excavated to determine whether they were individual plants or shoots from rhizomes, since the excavation would reduce the number of surviving cattails within the wetland area.

The variations in bottom contours and in water levels in the mitigation wetland were expected to result in variations in densities and species of vegetation. This situation is similar to what would be expected in vegetation reestablished in natural wetlands after a major disturbance. Areas that are too dry or too wet will have little or no wetland vegetation develop in any given year. In subsequent years, as water levels fluctuate, areas that were initially too wet or too dry will eventually experience water levels that are suitable for vegetation development.

Wetland vegetation that was already present adjacent to the mitigation wetland area included primarily cottonwood *(Populus sp.)*, willow *(Salix sp.)*, and cattail *(Typha sp.)* growing in the northwest corner of the wetland area. This vegetation does not appear to have been adversely impacted by the mitigation wetland construction. This is noted because EPA had expressed some concern about the mitigation activities affecting the survival of the already existing wetland vegetation located adjacent to the mitigation wetland.

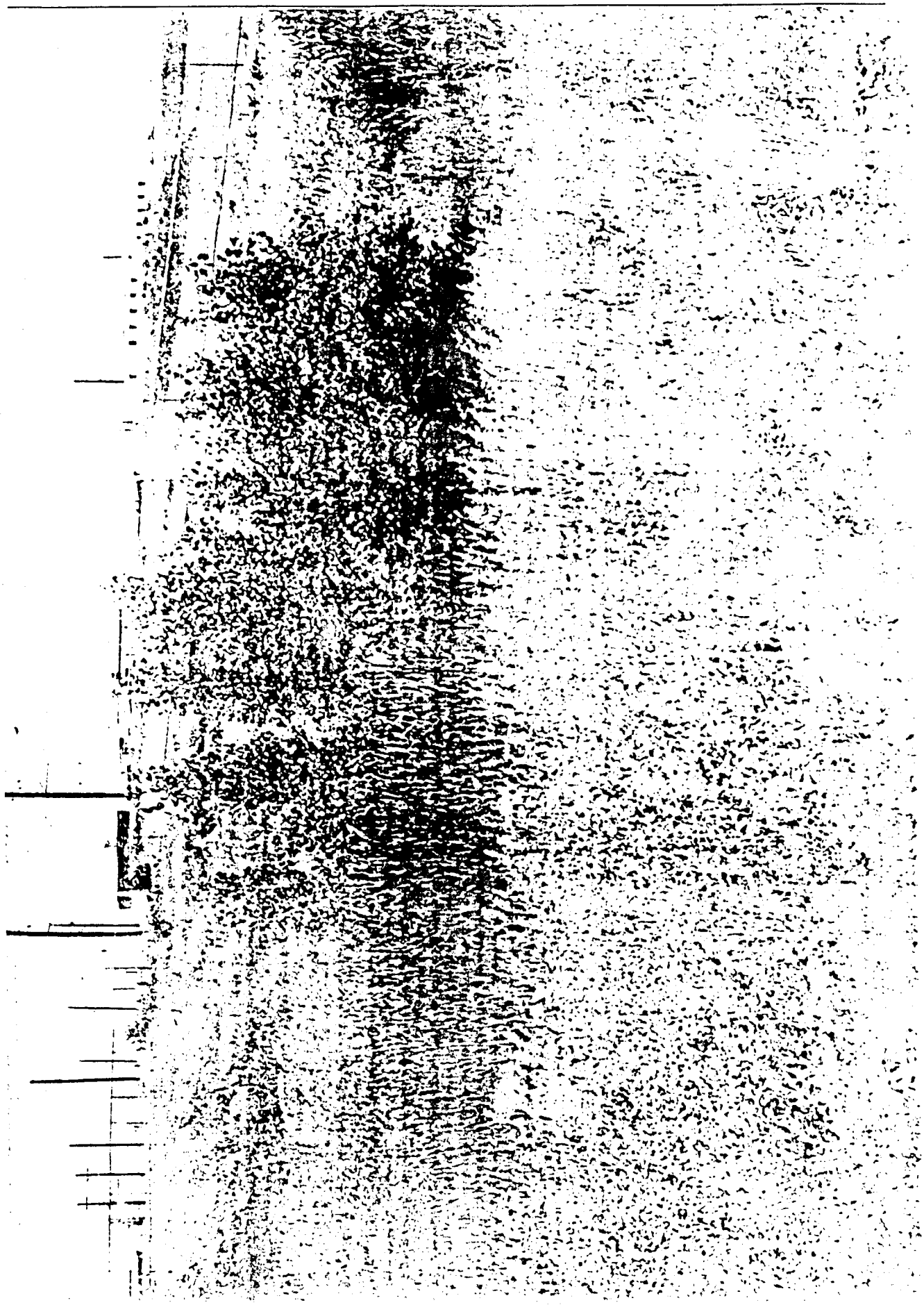

Figure 2. Photo Showing West End of Mitigation Wetland Looking Toward the Northeast.

Other species of vegetation have become established in the wetland. Table 1 gives a list of species that were observed on August 15, 1995 in the mitigation wetland area, below the apparent high water mark. Most of these species are represented by scattered individuals. Creeping spikerush (Eleocharis macrostachya) and Torrey's rush (Juncus torreyi) are becoming well established in some areas of the wetland through natural establishment. The willows, soft-stem bulrush, and Olney's bulrush plantings that were completed in 1993 along with the cattail plantings were not quantitatively evaluated, but they are surviving, and they are spreading into areas where they were not planted.

The mitigation wetland has been entirely dependent upon runoff from precipitation during calendar year 1995, with no water artificially applied.

The primarily bentonite bottom forms a hard crust as it dries out, which likely reduces the establishment of vegetation. During last year's survey of the wetland, it was noted that many of the plants that had established on their own appeared to have established in cracks in the bentonite, where moisture is retained longer, the surface does not harden as quickly, and seeds find an environment more suitable for establishment. During this year's survey, the area was wetter, and the substrate was not cracked as it had been last year. The lack of cracks at the time of this year's survey made it impossible to determine whether or not plants had established in cracks during the past year.

Some soil material is still eroding into the wetland from a small gully in the hillside to the north of the wetland. This material appears to have covered some of the cattails that were planted on the north side of the wetland. This eroded material has raised the elevation of the wetland bottom in the immediate area of deposition and has reduced the size of the area dominated by wetland vegetation.

Deer tracks and a recent deer bed were found in the mitigation wetland area.

The cattails in the mitigation wetland are not growing as well as if there had been additional water applied periodically. Application of water would likely increase cattail survival, but it would also make it more difficult to determine, within the five year monitoring period, whether the wetland is likely to survive without periodic human intervention.

TABLE 1

PLANT SPECIES OCCURRING IN OU1 MITIGATION WETLAND, 1995

Scientific Name[1]	Common Name[1]	Indicator Category[2]
Agropyron smithii	Western Wheatgrass	FACU
Agrostis stolonifera	Redtop	FACU
Ambrosia psilostachya	Western Ragweed	FAC
Asclepias speciosa	Showy Milkweed	FAC
Aster sp.	Aster	NL
Aster hesperius	Siskiyou Aster	OBL
Bromus inermis	Smooth Brome	NL
Bromus japonicus	Japanese Brome	FACU
Bromus tectorum	Cheatgrass	NL
Carex sp.	Sedge	FACW-OBL
Centaurea diffusa	Knapweed	NL
Cirsium arvense	Canada Thistle	FACU
Convolvulus arvensis	Field Bindweed	NL
Conyza canadensis	Horseweed	FACU
Eleocharis acicularis	Needle Spikesedge	OBL
Eleocharis macrostachya	Spike Rush	OBL
Epilobium ciliatum	Hairy Willow Herb	OBL
Epilobium paniculatum	Willow Herb	NL
Euphorbia serpyllifolia	Thyme-leaved Spurge	NL
Grindelia squarrosa	Curly-cup Gumweed	FACU
Helianthus annuus	Common Sunflower	FACU
Hordeum jubatum	Fox-tail Barley	FACW
Juncus bufonius	Toad Rush	OBL
Juncus interior	Inland Rush	FAC
Juncus torreyi	Torrey's Rush	FACW
Lactuca serriola	Prickly Lettuce	FAC
Melilotus officinalis	Yellow Sweetclover	FACU
Muhlenbergia asperifolia	Alkali Muhly	FACW
Panicum capillare	Witchgrass	FAC
Phleum pratense	Timothy	FACU
Plantago major	Common Plantain	FAC
Poa compressa	Canada Bluegrass	FACU
Poa pratensis	Kentucky Bluegrass	FACU
Poylgonum erectum	Erect Knotweed	OBL
Polypogon monspeliensis	Rabbitfoot Grass	OBL
Populus deltoides	Plains Cottonwood	NL
Rumex crispus	Curly Dock	FACW
Salix amygdaloides	Peach-leaved Willow	FACW
Salix exigua	Coyote Willow	OBL
Scirpus americanus	Chair-maker's Rush	OBL
Scirpus pallidus	Cloaked Bulrush	OBL
Scirpus validus	Great Bulrush	OBL
Taraxacum officinale	Dandelion	FACU

TABLE 1 (continued)

PLANT SPECIES OCCURRING IN OU1 MITIGATION WETLAND, 1995

Scientific Name[1]	Common Name[1]	Indicator Category[2]
Typha latifolia	Common Cattail	OBL
Verbascum thapsus	Common Mullein	NL
Veronica anagallis-aquatica	Water Speedwell	OBL
Xanthium strumarium	Cocklebur	FAC

(1) Nomenclature is taken from the National List of Plant Species that Occur in Wetlands: Colorado (Reed, P. B., Jr. 1988. National List of Plant Species that Occur in Wetlands: Colorado. U. S. Fish & Wildl. Serv. NERC-88/18.06. St. Petersburg, Florida) for all species that are included on that list. Scientific names for species not found on National List of Plant Species are from the Flora of the Great Plains (Great Plains Flora Association, 1986. University Press of Kansas, Lawrence). Common names for species not found on the National List of Plant Species are not standardized, but are taken from the Rocky Flats Plant Technical Standard EPM-END-CASCL (Current Approved Species Code List).

(2) Indicator categories are from the National List of Plant Species that Occur in Wetlands: Colorado (Reed, P. B., Jr. 1988. National List of Plant Species that Occur in Wetlands: Colorado. U. S. Fish & Wildl. Serv. NERC-88/18.06. St. Petersburg, Florida). The Region 5 Indicator (R5IND) was used. Region 5 includes Nebraska, Kansas, and Eastern Colorado.

INDICATOR CATEGORIES

OBL (Obligate Wetland) - Occur almost always (estimated probability > 99%) under natural conditions in wetlands.

FACW (Facultative Wetland) - Usually occur in wetlands (estimated probability 67%-99%), but occasionally found in nonwetlands.

FAC (Facultative) - Equally likely to occur in nonwetlands (estimated probability 34%-66%).

FACU (Facultative Upland) - Usually occur in nonwetlands (estimated probability 67%-99%), but occasionally found in wetlands (estimated probability 1%-33%).

UPL (Obligate Upland) - Occur in wetlands in another region, but occur almost always (estimated probability >99%) under natural conditions in nonwetlands in the region specified. If a species does not occur in wetlands in any region, it is not on the National List.

NL (Not On List) - Species is not listed on region 5 list. It may be on the National List in other regions.

NI (No Indicator) - Insufficient information was available to determine an indicator status

OU1 Mitigation Wetland - FIELD DATA FORM

Field Investigator(s): J. KRAUSE M. WOODRICK T. ALLISON Date: 8-15-95
Location: OU1 WETLAND MITIGATION Purpose: _____
Sheet 1 of 1

Quadrat	Quadrat Count Plants/0.5m²	Plants/m²	Quadrat	Quadrat Count Plants/0.5m²	Plants/m²
1	11	22	9	6	12
2	9	18	10	5	10
3	7	14	11	5	10
4	8	16	12	9	18
5	11	22	13	5	10
6	7	14	14	6	12
7	8	16	15	6	12
8	5	10	16	6	12
			17	7	14
			18	6	12

Sample size formulas

(1) $n = \frac{(2ts)^2}{w^2}$

= n = the number of samples required
= t = the t-variable for the sample at the stated level of error
= s = the standard deviation of the sample
= w = the width of the desired confidence interval

(2) $n = \frac{t^2 s^2}{(kX)^2} \quad \frac{(2.015)^2 (1.83)^2}{(0.10 \times 8.83)^2} = \frac{4.06 \times 3.35}{.883^2} = \frac{13.60}{0.78} = 17.44$

17.44 = n = the number of samples required
2.015 = t = the t-variable for the sample at the stated level of error
1.83 = s = the standard deviation of the sample
0.10 = k = the proportion or precision that the true difference of the sample mean occurs from the population mean
8.83 = X = the sample mean

NOTICE:

"BEST AVAILABLE COPY"

PORTIONS OF THE FOLLOWING DOCUMENT ARE ILLEGIBLE

The Administrative Record Staff